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Impact of permeability on seismoelectric transfer function of P waves

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Recent developments in the understanding of seismoelectrics have shown its potential relevance for porous media characterization with particular focus on permeability estimations. According to promising theoretical and numerical studies, permeability should influence the seismoelectric transfer function at higher frequencies. The dynamic seismoelectric transfer function E(ω)/ ü(ω), where E relates to the coseismic electric field induced by the seismic particle acceleration ü, is expected to increase with increasing permeabilities when crossing the Biot transition frequency. Still, only few experiments have been developed on that matter so far.

To address the transfer function dependence on permeability, we adapted a column experiment to comply with steady-state permeability estimations. These observations were run in-situ, during the fluid-balancing phase prior to seismoelectric measurements. The 50 cm-long column had previously been carefully filled with perfectly rounded glass beads. The use of sorted glass beads is expected to achieve similar porosities reproducible throughout the experiment, opposed to varying permeabilities depending on the introduced particle size. The acoustic source delivered compressional waves with an optimal effect limited to the [1-3] kHz frequency range. These limitations are due to strong seismic attenuation in uncompacted porous media on one side, and to the dilemma of observing propagation in downsized laboratory setup on the other.

First results validated the experimental protocol in terms of porosity/permeability independence: for particle size varying between 100 μm and 500 μm, permeability varied by a factor 20, with a maximum by 5.10^{-11} m^2, while porosity remained by 39 $\pm$ 2 % during the whole experiment. Further investigations are being led regarding the normalised transfer function, corrected for both the fluid conductivity and the seismic energy. For that purpose, we compare the dependence of our measured transfer function on permeability at a given frequency, to that predicted by synthetics, computed using our experimental permeabilities.